Quarterly Report, March 15, 1992
Quarterly Report for January - March
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CZCS algorithms for estimating chlorophyll a plus pheophytin a concentrations perform quite well for regions of the ocean where scattering and absorbing components of seawater covary with these pigments, Case I water. The accuracies of these algorithms, however, may decrease when environmental conditions depart from those representative of the data set used to empirically derive the covariance relationship, Case II water.

The widely varying Colored, Dissolved Organic Matter (CDOM) has a profound effect on upwelling radiance in the blue band 443nm of the CZCS and a smaller but still significant effect in the green band 520nm. Absorption at these two bands due to CDOM creates erroneously high estimates of pigment concentration in those models. Also, models which do not separate absorption due to viable pigments from absorption due to degradation products (DP) have less utility to researchers applying physiological primary production models or to researchers interested in DP rather than the pigments.

A previously developed semianalytical irradiance reflectance model has been modified to address the concerns listed above (Carder et al., 1991). The model was used to develop an algorithm that utilizes a 412nm spectral channel in addition to 443nm and 565nm channels to estimate chlorophyll a concentration and the absorption effects due to DP from irradiance reflectance data.

We are modifying this reflectance model to one of water- leaving radiance Lw(~). The algorithm for chlorophyll a and DP must also be changed accordingly. A critical concern is the spectral behavior of Eu(~)/Lu(~) = Q(~). This Q factor varies with solar zenith angle and b/c ratio values, and may be affected by viewing angle. A Monte Carlo radiative transfer simulation model for use in evaluating parameters affecting the Q factor in order to predict their spectral effect on water-leaving radiance is also being developed to compare with measured Q factor. The Q factor must be either known or predictable to accurately modify our CDOM and chlorophyll a algorithm for use with water-leaving radiance data. Improvements in the empirical relationships for the chlorophyll- specific absorption coeffient as a function of bio-optical provinces are also needed to optimize the algorithm for various seasons and locales (see Carder et al. 1991).

A method to calibrate the AVIRIS data based on water leaving radiance measurements and atmospheric corrections using a LOWTRAN-7 program, has been developed, and a paper has been submitted for publication (Carder et al., submitted). This method permits aircraft-measured radiance data to be merged with in situ field data to serve as a tool for satellite algorithm development and testing. The AVIRIS sensor has better than 10nm spectral resolution from 400-1000nm and can be used to simulate HIRIS, MODIS-N, and SeaWIFS data by pixel binning. This also helps improve S/N which is probably 4x to 6x less than expected for HIRIS on a single-pixel base.

AVIRIS data from Tampa Bay and Lake Tahoe together with our supporting in situ data were used in the last several months to refine our reflectance model for quantifying chlorophyll a in Case I and Case II waters. The effect of bottom reflectance must be accounted for in much of this coastal data.

We have also been considering algorithms for bathymetry using AVIRIS data and field measurements from Lake Tahoe and the west Florida shelf. These can be used for several purposes: 1) measure bathymetric changes due to hurricanes or other sediment transport mechanisms, 2) define where and when algorithms will be affected by bottom reflectance, 3) correct or modify algorithms to perform adequately in the presence of bottom-reflected radiance, 4) map sea grass or algal beds and monitor their changes. The second and third purposes are directly pertinent to algorithm performance for the relatively clear shelf waters of most subtropical/tropical coasts.

We have derived the bottom albedo by comparing modelled depths with bathymetric charts and adjusting the albedo until a match is reached. Generic spectral albedo curves for sands from the West Florida Shelf have been determined for a few, diver-retrieved samples for comparison. We consider that the results found so far are very reasonable. A new Spectral Upwelling and Downwelling Sensor (SUDS) is being developed with NASA Core program funding, which will be useful in measuring/confirming bottom albedo curves during future cruises. The effects of bottom reflectance will be incorporated into the model for Case II waters, and algorithms for chlorophyll a calculations will be evaluated in terms of the error that is induced by bottom reflectance.

A cruise in the eastern Gulf of Mexico is planned where appropriate in-water data will be collected on May 1992. The Airborne Oceanographic Lidar (AOL) of Frank Hoge will overfly this cruise to detect gelbstoff fluorescence and water Raman emission. The fluorescence and water Raman emission data can then be used to relate to gelbstoff optical emissions.

References:

1. Carder, K.L. et al., Reflectance model for quantfying chlorophyll a in the presence of productivity degradation products, J. Geophys. Res. 96(C11): 20599-20611, 1991.

2. Carder, K.L. et al., AVIRIS calibration and application in coastal oceanic environments, G. Vane ed., Remote Sensing of Environment Special Issue on Imaging Spectrometry, 1992, submitted.